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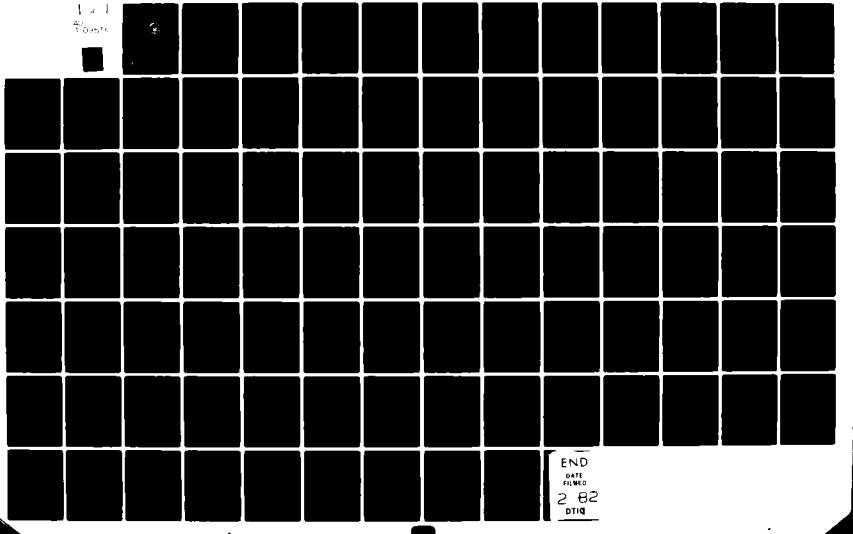

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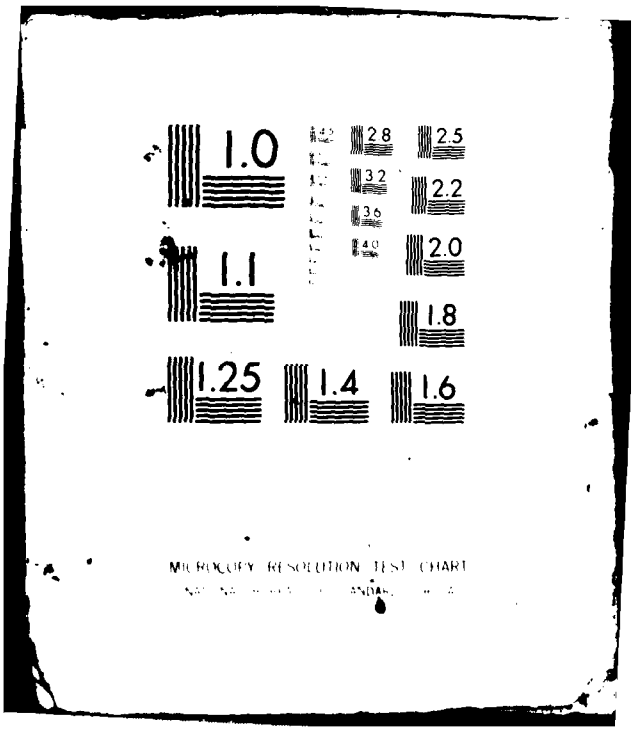
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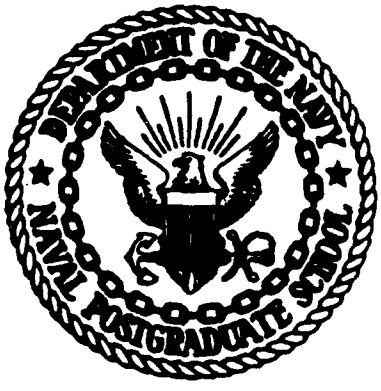

THESIS

EMPIRICAL ANALYSIS OF SYSTEMATIC COMMUNICATION ERRORS

by

Timothy B. Born

September 1981

Thesis Advisor: R. H. Weissinger-Baylon

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Empirical Analysis of Systematic Communication Errors

by

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requirements for the degree of

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ABSTRACT

This study is concerned with the causality of systematic communication errors encountered in Marine land combat operations in Vietnam. Source data was compiled from an examination of after-action reports maintained at USMC Archives, Washington, D. C.. The fundamentals of Information and Communication Theory are explored first, in an effort to understand the phenomena (psychological and physiological capabilities and limitations) affecting the "human link" in information and communication systems. This background served as the foundation regarding the development of a communication error model to explain the anomalies encountered in human behavior in military operations of high intensity. From this model, inferences were made regarding the practicality of implementing Decision Support System's (DSS's) to eliminate the systematic communication errors discovered.

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I. INTRODUCTION

A. GENERAL

War, as Karl von Clausewitz stated in his great treatise indited over 150 years ago, is a complex phenomenon that touches every science and draws from them all. In addition to encompassing machines, weapons, strategy and tactics; the Laws of War must consider the psychological aspects and physiological limitations of individuals. These conclusions, drawn from von Clausewitz's personal examination of past and imagined future battles are accepted as universally applicable, as they reflect typical elements regarding the main problems a commander must consider in military operations. The recognition of these latter two factors of war on the modern battlefield requires particular attention in view of the increased demands placed on the individual by technology, and the high absolute value inherent in most decisions executed in a combat environment.

B. HYPOTHESIS

The general hypothesis underlying this research was that a large number of unsuccessful land combat operations could be attributed to systematic errors committed by the human

components in communication systems. (Systematic errors were defined to be those that occur regularly in human communication links). Although communication systems entail both a hardware and a human element, consideration of the former was disregarded due to the prolific research already accomplished in this area. (Available studies reflected a proclivity by analysts to measure overall system success strictly as a function of hardware performance).

The Vietnam War generated an extensive amount of battlefield information, much of which has never been analyzed. Data on information and communication has been especially neglected. In view of this, it was hypothesized that an examination of a random sample of after-action reports (historical narratives summarizing operation) would isolate human, organizational and situational variables which adversely affected human information processing abilities. These variables, imputed upon individuals working under the degraded conditions of the battlefield, would in turn generate systematic communication errors contributing to, or resulting in, failed missions. For the purpose of this analysis, mission failure was measured in terms of the absolute error (i.e failed operations,

sustained casualties) inherent in the final outcome of all decisions.

C. PURPOSE

The purpose of this study was threefold.

1. Communication Errors

Errors can be system, design or human induced. In view of this, the first step in learning to communicate more effectively is to determine exactly what types of errors exist. As such, a random sample of after- action reports was analyzed in order to isolate and categorize those variables (actions,situations,events) which were associated with or contributed to systematic communication errors encountered in land combat operations. These variables were extracted from operations classified as failures within the sample, after examining the associated information content, interpretation and flow contained therein. The specific intent was to identify the antecedent conditions and resultant consequences associated with the recurring communication errors.

Whereas most research emphasized specific instances of communication errors, this study concentrated on identifying systematic or recurring errors. Furthermore, if

the occurence of these errors could be explained in terms information and communication systems, they could also be corrected.

Although it is recognized that the effective and efficient operation of any system is a function of both equipment and operator performance, the specific issues addressed here were the capabilities and limitations of the human in information and communication systems in a combat environment. Specific issues focused upon were attitudinal and behavioral phenomena associated with humans in communication systems. As such, this study was concerned with human and system induced errors, as the design induced errors (i.e. faulty equipment) were considered noninteresting and had already been extensively researched.

2. Communication Model

After conducting the study to determine exactly what systematic errors are present, an effort was made to construct a communication model to explain the causality of communication errors discovered in land combat operations. The specific intent here focused upon the premise that a suitable model would make the users within the communications system more cognizant of the variables

affecting optimal system performance (for the given situation).

3. Decision Support Systems Applications

Following these two objectives, an effort was made to determine the impact a Decision Support System would have with regards to alleviating or eliminating these errors. As the efficient and effective operation of any Decision Support System is a function of individual, organizational and environmental phenomena; the specific intent here was to determine the practicality of implementing a Decision Support System in view of the errors discovered and model developed.

D. SCOPE

One of the major tenets in any comparative study of human capabilities and limitations is that performance ceilings should first be established under optimal system conditions, followed by degraded performance limits under less than ideal conditions. As such, a condensation of the exhaustive research conducted in the fields of information and communication theory is presented first. This material reflects the components contributing to optimal human performance in each system. It is in turn followed by

examples of degraded performance in information and communication systems experienced by troops operating in Vietnam. These examples were drawn from the wealth of material covering Marine land combat operations in Vietnam during the years 1965-1972 inclusive. From this population was drawn a random sample from which the inferences contained herein were made.

E. LIMITATIONS

The reader is assumed to have limited knowledge of the human dimension in information, communication and decision support systems. Additionally, expertise with Marine land combat operations is not required as examples of communication errors discovered will be presented on a conceptual versus fundamental basis. In view of this, a framework will be laid for both information and communication systems to include the human dimensions inherent in each. This will enable the reader to more fully appreciate the conclusions drawn from the sample to follow.

F. METHODOLOGY

During the course of the war, a series of post operational or after-action reports (lessons learned) was generated to inform commanders of high risk tactical

procedures which were believed to contribute to avoidable combat casualties. Due to the duration of the war, political considerations and foreign intervention, the Marines experienced a dynamic role reversal in their basic mission during its most formidable years (from a limited defensive strategy to a dual strategy which involved conducting simultaneous offensive and pacification operations). During this period, thousands of combat missions were executed of different natures and intensities by various size units (reconnaisance patrols through Battalions). As such, the table of random numbers contained in Degroot [Ref. 1]. was utilized to select a random sample of over 150 operations and after-action reports for examination covering these years. Given that the table contained 9999 four digit random numbers, and that after-action reports were cataloged alphabetically, each operation was selected by choosing a number in the table, and sequentially matching the first two digits to a letter in the alphabet, and the last two digits to the corresponding report number in the file. This was accomplished to preclude unnecessary bias from entering the sample regarding the type and frequency of communication

errors encountered as a function of time, nature of operation, and size of engaged units. In short, during the period 1965-1972, all operations by all size units were subject to scrutiny. From this sample, inferences were made regarding recurring factors which contributed to communication errors resulting in nonessential casualties or failed missions.

G. APPROACH

Due to the nature of land combat operations, any Decision Support System implemented therein would require heavy investitures in communication systems. As such, this analysis progresses through three systems of various natures and differing degrees of complexity.

As an overview, a brief synopsis of Marine land operations in Vietnam will be presented first. This will in turn be followed by a discussion of information and communication systems respectively. Following this, a listing and analysis of systematic errors committed in Marine land combat operations in Vietnam will be presented to be followed by the development of a communication error model. This discussion will be concluded by integrating the findings discovered above, with the characteristics of

Decision Support Systems in an effort to determine the latter's usefulness with regards to alleviating or eliminating the systematic errors encountered.

II. BACKGROUND

Marine involvement in this nation's most recent and protracted war began with the introduction of a single Marine advisor into Vietnam in 1954. The first Marine tatical unit deployed to Vietnam in April 1962 as evidenced by the arrival of Marine Medium Helicopter Squadron 362 (HMM-362). Buildup of Marine air and ground units started in March 1965 with the arrival of the 9th Marine Expeditionary Brigade. This buildup resulted in the evolution of the III Marine Amphibious Force (III MAF) which eventually attained a peak strength of 85,755 Marines in September 1968. It was not until the Saigon evacuation on 9 December 1972 that the last Marine was withdrawn from Vietnam.

During the war's peak years (1965-1971), approximately 730,000 men and women served in the Corps; 500,000 of them serving in Vietnam. During the years 1 January 1961 through 9 December 1972, combat casualties sustained by Marines operating in Vietnam included:

1. Killed in Action (KIA): 12,936 (28.4% of 45,915 U.S. total).

2. Killed (non-battle): 1,679.

3. Wounded in Action (WIA): 88,589 including 55,389 requiring hospitalization (33.5% of 153,256 U.S. total).

These statistics garnered from FMF historical summaries [Ref. 2] reflect that the engagement billed as the "nation's nightmare" in the '60's, represented the greatest U. S. military commitment since WW II (The Marine's personnel commitment and combat casualties actually exceeded WW II figures). The United States withdrawal from Vietnam in 1972 generated a series of ex post facto reports postulating different authors views criticizing various facets (i.e. communications, logistics, tactics...) of military operations which were believed to have contributed to a significant number of nonessential combat casualties. The critiques for the most part took a microcosmic view of military operations as they emphasized factors such as faulty weapons, poor maintenance procedures and unreliable communications hardware. These evaluations failed to recognize that the total success of a system is determined by environmental factors affecting the performance of men as well as machines.

At the other extreme, S.L.A. Marshall reckoned that at one point in the War: "about one third of our losses in

action were our fault, owing to carelessness" [Ref. 3]. Although the impact of these factors on some otherwise avoidable casualties is recognized, examination of a sample of after-action reports reflect that the human dimension was a major contributing factor to systematic communications errors in many instances. As recognized by Clausewitz in the 18th century, War has a human as well as a hardware element. And if war is to be conducted successfully, this factor must be accounted for on today's battlefield, especially as it relates to such critical components as information and communications systems.

Historically, not enough attention has been directed at this facet of warfare. In particular, communications has been described as a passive element of land warfare as it does not contribute to the neutralization or destruction of the enemy. Its aim is not the excision of the enemy from an area, but rather the uncompromising flow of information to and from units directed at "compelling our adversary to do our will". [Ref 4]. As such, it has never been placed on the asset side of the balance sheet, which has resulted in superficial scrutiny of the causality of communication errors when they did occur in land warfare engagements. The

proclivity of analysts in the past has been to attribute these errors to hardware failures, improper training, lack of education, etc..., when infact more latent phenomena may be the principle contributing agent.

If communication errors are ever to be completely eliminated in a system, all contributing agents as to their occurences must be accounted for to include the human element (psychological, physiological and behavioral characteristics of individuals). Once this is accomplished, only then can an effective Decision Support System (DSS) relying heavily on communications be designed for, and implemented in a high intensity environment such as the modern battlefield.

III. INFORMATION THEORY

A. GENERAL

The basic contention of information theory is that information's primary purpose is to reduce the amount of uncertainty (i.e. event that is probabilistic but where the parameters are unknown) present within an organization or system. The functioning of an information system can be described by the second law of thermodynamics, which states that any open system (no energy input) over a period of time will tend toward a state of maximum entropy (positive measure of randomness or disorder). As such, the amount of information required by an organization to maintain a given level of performance (order) is directly dependent upon the entropy present within a system. For the greater the entropy surrounding an organization (i.e. combat unit), the greater is the demand for information as reflected by the number of transmitted messages. This demand for information serves to reduce the associated uncertainty (unavailable information), thereby prompting order and enabling the organization to maintain control.

Ashby's Law of Requisite Variety addresses this issue quantitatively by stating that the internal communication capacity (amount of information transmitted and received) within a system must be no less than the turbulence of the environment surrounding it if the system is to maintain control. Thus, organizations finding themselves in "friendly" environments (low turbulence), have little or no uncertainty and therefore require a minimal amount of information to maintain control.

At the other extreme, organizations such as the military may find themselves in highly turbulent environments, and should therefore be heavy investors in information processing systems. Mechanisms employed in such systems directed at coping with a high degree of uncertainty include:

1. Coordination by Rules: increases the information processing capabilities of an organization by allowing inter-unit activities to transpire without communications, but is applicable only in those situations which can be predicted in advance; and hence, a response preprogrammed accordingly.

2. Coordination by Goals: reduces information processing requirements by specifying goals to be achieved by all participants. The intent of this procedure is to reduce the amount of coordination (information transmitted) required to keep all units abreast of the situation and on a common course of action.

3. Hierarchy: is used to increase the information processing capabilities of an organization when coordination by rules or goals is not applicable; and as such, "situations are referred to that level in the hierarchy where a global perspective exists for all affected subunits". [Ref. 5]. The danger inherent in this mechanism however, is that due to the pyramidical structure of vertically integrated organizations, the decision point may eventually become overloaded.

Of the three mechanisms utilized to increase the information processing capabilities of a system, the latter is most applicable to a military organization engaged in a combat environment. Reliance upon the first two mechanisms is limited due to the dynamic role reversals experienced by, and time constraints imposed upon, units engaged in combat. The third mechanism is not without its shortcomings however,

as the examples illustrate it is subject to biases peculiar to information transmitted between two different hierarchal levels.

B. SPECIFIC

Information is data (familiar to both the source and the receiver) that has been processed into a form that is meaningful to the recipient and is of real or perceived value in current or prospective decisions. As treated in this context, information is a resource that has utility by reducing the uncertainty within an organization provided that it is timely, accurate and relevant. Supporting this argument is the fact that not all communicated information reduces uncertainty. To be of value, information must elicit the desired interpretation, response, or action from the recipient (decision-maker). As such, information must be conveyed to the recipients in such a manner so as to enhance its use in operational situations. This implies that a selective filtering of information must occur prior to transmission in order that the sender may tailor the message to the enviornment, task at hand, and capabilities of the decision-maker. This tailoring serves to accomodate the human whenever he is viewed as an information processor.

Besides being saddled with the routine information processing duties not involving human cognition (reception, storage, retrieval), the individual may be required to execute more complex cognitive assignments (judgement and decision-making). The successful execution of these latter two information processing tasks is especially critical in noisy (information not intended by the source) environments, as their outcome may determine the long term survival propects of an organization. To ensure the correct perceptual distinction is made for each, it is imperative that only relevant information is conveyed to the recipient, in order to elicit the intended response. As humans have ceilings regarding their ability to process the amount and rate of information, communicating superfluous stimuli will result in sub-optimal performance once the individual's threshold is exceeded. In view of the limited capacity of humans, caution must therefore be exercised to ensure that the "selective sample" of information communicated to the individual prompts the appropriate response. Condensation of information must therefore occur without a loss of content.

The method for transmitting (visual, auditory, or tactile) information is also critical, as some have intrinsic advantages over the others depending upon the environment. Given that in land combat operations messages are usually short, simple and deal with events in time, extensive research has proven that an auditory method of information transmission is the most appropriate. This determination is also supported by the fact that many messages call for immediate action (i.e. on-call fire support, resupply...), and by a person required to move about continuously. The bearing these factors have on the implementation of Decision Support Systems will be seen later.

In summary, the effective communication of information serves to change the probabilities associated with expected outcomes in a decision situation, highlighting the intimate nature of information, communications, and decision theory.

C. CHARACTERISTICS

Information may be characterized by:

1. Quantity

Quantity is concerned with how much of the original message is received, as there exists man-made restrictions

and human constraints placed upon the amount and rate of information that may be effectively communicated to an individual. Thus, some degree of "data compression" is mandatory if information is to be transmitted error-free between human components of a communication system.

a. System/Organization Induced

"Tailoring stresses the effective and timely communication of information (of the correct quantity and quality) to the decision- maker. As such, tailoring is a concerted effort by the sender to make the message user compatible to the task at hand. The type, amount rate and construct of information is therefore transmitted with respect to the operating environment and capabilities (skills, knowledge, experience) of the recipient.

The amount and type of information furnished to a decision-maker is a function of his relative position in the organizational hierarchy. Applying the tailoring concept, when communicating upward in a hierarchy, information about the internal environment (control-oriented) should be condensed while information about the external environment (planning-oriented) should be amplified. For information communicated downward within the

hierarchy, the reverse is true. These actions are mandatory due to the nature (strategic and operational respectively) of decisions required by individuals occupying the upper and lower echelons in a hierarchy. Conformance to such procedures is especially critical in a military organization, where rank determines the level of vertical integration of an individual within a unit. The position one occupies in the hierarchy should therefore be considered prior to transmission to ensure the free exchange of information. This practice not only recognizes the structure of an organization, but the inherent capabilities and limitations (i.e. skills, experience, knowledge) of individuals occupying different decision points within the structure. The impact of a decision by an individual occupying a seat at the apex of the pyramid, is therefore far more reaching than a decision executed by an individual occupying the base of a hierarchically structured organization.

Redundancy (increasing the total information in the system over a particular period of time) is an means that may be employed in either of the transmission modalities above, and serves to minimize information loss

whenever channel noise (distortion, interference) is present. However, besides being grossly inefficient, this practice does not lend itself for implementation in a military environment, in view of the severe time, security and channel capacity constraints associated with military operations.

b. Natural

The amount and type of information correctly received and interpreted by an individual is subject to the psychological limits as described by Miller [Ref. 6]. Additionally, stress, strain and fatigue have particularly deleterious effects on the ability of a receiver to effectively function as a decision-maker when in receipt of pertinent information.

2. Quality

Quality is concerned with whether or not the received message conveys the intended meaning of the transmitted message. This implies minimal relevant information loss or modification during transmission. As such, quality is affected by errors and biases introduced during the transmission or interpretation of a message respectively. With regards to biases, they originate due to

the perceiver responding to unknown cues. If biases can be detected, their correction is a simple matter of adjustment.

Errors on the other hand are more subtle to detect and difficult to correct. The presence of errors as well as biases in information will be examined in Chapter 4 with regards to their impact on communication systems.

3. Effectiveness

Effectiveness implies eliciting the desired impression or response from the recipient. As such, information is considered to be effective if it:

1. informs - changes the probabilities of a choice

2. instructs - changes the efficiencies of a course of action

3. motivates - changes the values of the outcomes [Ref. 7].

Thus, the effective transmission of information reduces the uncertainty thereby enabling the decision-maker to determine an appropriate course of action for the situation at hand. Effectiveness is therefore dependent upon the degree of tailoring by the sender, as it exists only of the correct individual, receives the correct information at the correct time. Effectiveness is also

intimately related to the functional approach definition of communication to be discussed later.

In view of the aforementioned, information can be characterized by three components (quantity, quality and effectiveness) and a variety of attributes (timeliness, accuracy, relevancy...). Information has utility or value only when it serves to reduce the uncertainty of the decision-maker for a particular situation. The basic functions of an information system entail determining the recipient's needs, selecting and tailoring available information, and communicating this information to the user. The phenomena associated with this latter function will now be discussed.

IV. COMMUNICATION THEORY

A. GENERAL

As surmised by Clausewitz nearly two centuries ago, "Lines of communication form the connection between the army and its base, and are to be considered as so many great vital arteries. These life channels must therefore neither be severed nor interfered with,...as some strength is always lost,...and the army may grow feeble and die away" [Ref. 8].

Although today's communications encompasses a host of activities (radio, telecommunications, satellite transmission...) never envisioned by Clausewitz, his basic premise holds true in that the communication of information remains the life stream of all organizations.

Communications in combat occupies a particularly precarious position as it is oftentimes required under seriously degraded environmental conditions (battlefield noise, exhausted personnel), and as such, there exists peculiar situational and human variables attempting to sever it. A military commander must therefore recognized and control these variables if he is to ensure a continuous and current flow of information to/from his satellite units.

Once this is accomplished, effective and timely decisions can then be communicated to subordinate leaders.

As such, communications is the one common denominator that enables a combat organization to become a coordinated and responsive fighting unit. And if functioning properly, it serves as a synergetic mechanism by integrating the actions of individual men and weapons into a formidable tactical unit.

B. SPECIFIC

The purpose of communications is to inform the recipient about a situation in which he has no contact in order to elicit a particular response. This reults from the fact that all relationships between humans involve some form of communication. And as such, it is a factor that must be reckoned with for every human problem encountered in the working environment. It is regarded as the principle driving force behind most organizations, and is particularly critical to those experiencing a great deal of turbulence or uncertainty. To recapitulate the comments of the previous section, the greater the uncertainty, the greater is the demand for information. This in turn requires accurate communication to ensure the correct people, get the correct

information, at the correct time, in crder for an effective decision to be reached. This decision however, has no value in and of itself, as it must be communicated to others in order to be acted upon. From a global perspective then, information, communication and decision theory and systems are interrelated.

Having first examined information theory, communication theory will now be discussed in an effort to determine the causality of communication errors discovered in land combat operations in Vietnam. These results will then be integrated with the two aforementioned theories in an effort to construct a communication error model (analog or representation) to be considered in the design and implementation of a Decision Support System for land combat operations.

Communication is most often thought of as the exchange of information between two parties. This information is transmitted via a channel between a sender and a receiver during which it is subject to a host of environmental influences which may alter the quantity and quality of the original communique. However, understanding and evaluating communications and its associated problems is not that simple as the following viewpoints (approaches) reflect.

Individuals in the era that spawned the term the "nation's nightmare", are also credited with coining the phrase "communications gap". Although this latter term has been abused, it still remains a source of considerable consternation. Only recently has it come under intensive scrutiny, for it has finally been recognized that the time and effort it takes to ensure a communication is initially understood, is far less costly than straigtening out a misunderstanding, particularly in high intensity situations.

One of the agents contributing to today's communication problems has been the dilemna of agreeing upon a common definition for the term "communication". For if communication is defined in different ways, errors encountered therein are also evaluated in different ways, some of which may be completely irrelevant with regards to explaining the problem at hand. Lin [Ref. 9] collated the most common definitions of communications into the following approaches to include his own.

1. Definitions

a. Elemental Approach

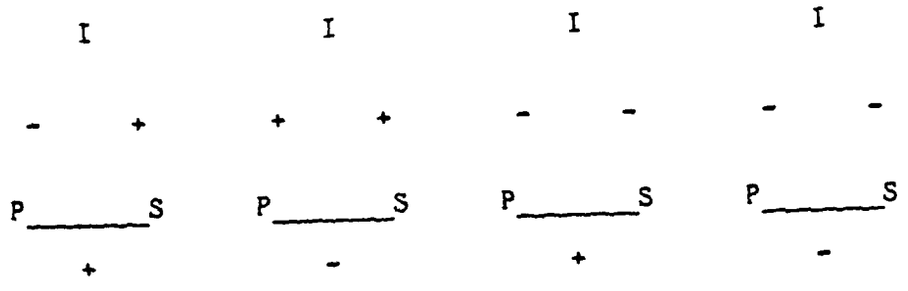
This approach is probably the most widely recognized , as it attempts to specify communication systems

in terms of its structural components (elements). It resembles electrical engineering models, by introducing "noise" into a channel carrying a message between a transmitter and a receiver. It also highlights the fact that communication is a two way interactive process, as the role of the sender/receiver is a reciprocal relationship as a rule rather than the exception.

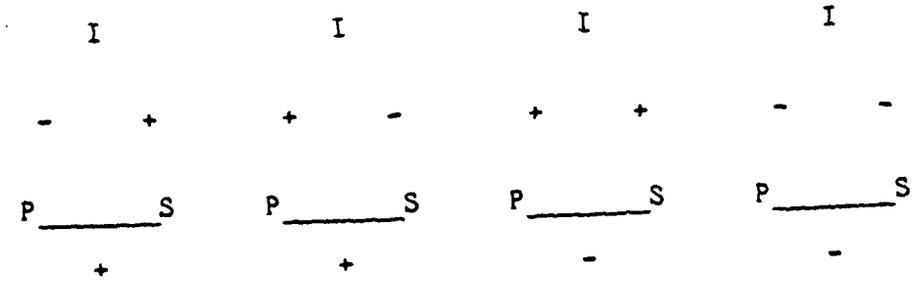
b. Process Approach

The process approach takes a cognitive view of communication systems. It attempts to explain their effectiveness as a function of balanced or unbalanced states as determined by a person's attitude toward a source and an issue, and the perceived assertion of the source about the issue. When each of the components of the process approach is considered as the corners of the triangle, binary values can then be assigned to each side of the triangle as a function of the states between two corners (i.e. balanced state = 1, unbalanced state = 0). Algebraic multiplication of the three sides will yield either a balanced (effective) or unbalanced (ineffective) communication system. Thus, only one, or all of the sides must be balanced to ensure an overall balanced system. When the configuration is

unbalanced, balancing occurs only through actions or cognitive changes in the person's outlook. Fig. 4.1 illustrates this approach.



Balanced Configurations



Unbalanced Configurations

Figure 4.1 Conceptual Approach

c. Functional Approach

Essentially, this approach defines communication simply by specifying the function the message serves (i.e. informational, instructional, motivational).

Myriad other attempts have been made to define communications adding to the confusion with regards to its study. These attempts define communications as everything from a "learning process" to the question of "Who says what in what channel to whom with what effect"? Obviously these latter definitions do not lend themselves toward effective analysis, and therefore, the communication errors discovered will be analyzed in terms of the three principle definitions. Each approach presents a different perspective regarding the role of humans in communication systems, and as such will be called upon to explain the problems discovered therein. Before proceeding however, one novel approach to the definition of communication bears attention.

d. Conceptual Approach

Lin [Ref. 10] has integrated the aforementioned definitions of communications into an all encompassing conceptual framework that focuses upon the human interactions aspects of communications. It is

concerned with more than a mathematical explanation (systematic relationship in the quantity and quality of information between input and output) as it focuses upon attitudinal and behavioral phenomena associated with efficient and effective communications. As such, Nan Lin attempts to maximize the vantage points from which human communications and its associated errors can be viewed. It consists of the four phases described below.

(1) Encounter. This is the first phase of the human communication process and focuses on the linkage between a specific piece of information (and the receiver) and the transmission medium. Its fidelity is therefore a function of both information and delivery systems.

(a) Information System:

With regards to the information system, to be of value, information must be novel and comprehensible (easily encoded and decoded) if it is to reduce uncertainty and be considered worthwhile. These factors have particular relevance in military operations where individual and unit performance is so dependent upon keeping informed and "passing the word".

(b) Delivery System:

With regards to the delivery system, Nan Lin states transmission is affected by the:

1. Noise introduced by the source, receiver , channel or environment, as human transmissions do not as a general rule occur under perfect (noiseless) conditions.

2. Channel capacity being exceeded. This implies that when the sender and the receiver have different transmission capacities, the lesser of the two cannot be exceeded if communications are to be successful. If this encoding/decoding differential is not recognized, redundancy must be employed to compensate for information that would otherwise have been lost. (Difficult to do in combat). This factor bears particular attention given the age, experience and educational differential inherent in the hierarchical interpersonal relationships in the military.

3. Spatial Network such that the frequency of interactions among people is inversely related to the physical distance between them. Research here has proven that while closer physical space usually promotes interpersonal communication, it can also generate problems if taken for granted (i.e. carelessness). This phenomena may help to explain the cause for "not passing the word".

4. Social Network such that the amount and direction of communication flow is a function of ones societal/hierarchical status. As a rule, low-status individuals initiate communications with high- status subjects more frequently than the reverse. This bears particular relevance in the types of systematic errors discovered as a function of the directionality of communication flow.

(2) Exchange. Exchange is the next phase in human communication and entails a concerted effort on the part of the sender and receiver to share and understand the transmitted message. Thus, the participants attempt to respond to each others messages.

(3) Influence. The third tenet in Nan Lin's view of communication states that the communication source exerts some effect or influence over the receiver. This influence may affect either of two dimensions of the human profile as either his psychological (attitudinally oriented) or behavioral (action oriented) perspective or response respectively on a particular issue in a particular situation may be altered as a result of his participation in encounter and exchange. Nan Lin explains this phenomena by stating

that influence may be defined as "the discrepancy between (a) a person's attitude toward an object or situation, or his behavior patterns, before his voluntary or involuntary participation in encounter and/or exchange and (b) his attitude or behavioral patterns after such encounter and or exchange" [Ref. 11]. Note the emphasis is on the term behavioral pattern as opposed to behavioral incidents.

Although many diversified theories have been postulated to explain this phase, they all focus upon "the change as expressed (attitude) or performed (behavior) by the receiver from communication" in a particular situation [Ref. 12]. Behavior is defined to be an overt gesture, acted or spoken which is verifiable by others.

(4) Adaptation and Control. Adaptation and control serves as a cybernetic mechanism which prevents the communication system from deteriorating. To accomplish this task, feedback is utilized to establish a two way flow of communications (as the first three phases were concerned with unidirectional flow) between the source and the receiver. Specifically, negative feedbak is used to inform the source of the extent to which communication has failed.

C. CHARACTERISTICS

1. Classification

Human communication is classified according to the level of analysis (number of people involved and direction of flow) under survey.

a. Intrapersonal

First and foremost comes intrapersonal communication which focuses upon the cognitive processes within the individual. This facet of communication has been determined to be the bridge between an individual and his behavior, and is the chief concern of psychologists and socialogists. Nan Lin states that this is process that enables a person to "come to grips with himself" (i.e. become a social being) by viewing himself objectively and responding to stimuli as he would expect others to respond. As we shall see, this process may override the following classes of communications.

b. Interpersonal

Interpersonal communication occurs between two or more individuals. Associated with this type of communication is the reciprocal relationship between sender and receiver which pervades most systems. Problems

encountered in this type of interaction are the chief concern of this study.

c. Societal/Mass

Societal/Mass communications involve a significant number of individuals affected by a certain communication media (TV, newspaper) with no interactive exchange of information. This classification will not be considered in this discussion.

2. Roles of Humans

As described by Campbell [Ref. 13], humans can assume two different roles in a communication system, each of which has inherent systematic errors. He emphasizes that if these biases can be recognized as being likely to occur in particular situations, they can be compensated for. And, if their existence is not recognized, ineffective communications will persist.

a. Duplicatory Transmitter

The simplest and most common role a human assumes in a communication system is that of a duplicatory transmitter. His role while functioning in this capacity is to merely relay information without a change in form. Despite the triviality of this task, it generates the most

errors. This results from the fact that a human employed in this manner must encode, call memory, and decode information asynchronously (as opposed to a machine which conducts these operations synchronously). In view of this, such operations are more suited for machines than men.

b. Reductive Coding

The other major activity a human performs in a communication system is reductive coding. His primary function here is to "collapse" a complicated input signal into a simpler and more comprehensible message that has relevance with regards to making decision. Due to the greater complexity associated with this task, more and different systematic errors surface when the human is operating in this capacity.

V. COMMUNICATION ERRORS

This section highlights the systematic errors most frequently encountered during the course of the research. For ease of reference, related incidents are considered collectively and classified under their most easily identifiable characteristic (i.e. action/event transpiring at time of communication failure). Specific incidents of communication failure for each category are listed for illustrated purposes only. Additionally, the principle causes and effects of each type of communication failure are enumerated.

1. Medevac Requests:

Some of the most costly (measured in terms of sustained casualties) incidences of failed communications occurred during "coordinated" Marine air-ground missions, particularly those involving helicopter operations supporting air medevac (medical evacuations) requests. It was not uncommon for the ground commander to transmit the medevac request and then change frequencies to monitor and control ground operations. As a result, coordination between the responding helicopter commander and on-scene

ground commander was impossible due to the latter's failure to maintain communications on the designated frequency (ground commander preoccupied with ground communications). Despite the lack of communications the dispatched helicopters oftentimes attempted to fulfill their missions blindly, by entering the LZ's (landing zones) without knowledge of the essentials (wind speed and direction; zone obstructions, markings and security...). Although it was recognized that these missions usually took place under hostile conditions, 1st MAW statistics [Ref. 14] reflected the severity of the problem, as although medevac missions accounted for only 7.5% of the total number of helicopter missions, they accounted for 32% of total crew casualties.

2. Fire Support:

Whereas communication failures during medevac operations resulted in casualties, communication failures during fire support operations resulted in unfulfilled missions. Two recurring types of errors were discovered.

First, there were numerous instances noted where mission failures could be attributed solely to the lack or mismatch of a piece of a highly utilized piece of "hardware" - a shackle sheet (coded sheet used to decode an encoded

transmission). This problem surfaced primarily when mission requirements dictated communications between independent but supporting units (reconaissance, infantry, artillery,...). For example, intra-Battalion errors of this nature were not noted, however, inter-unit (i.e reconaissance patrol and artillery battery) activities tended to generate these occurrences. This oversight resulted in many lost targets of opportunity.

Secondly, mission failures oftentimes resulted form inordinate delays associated with fulfilling safety (i.e. confirming danger close limits and/or save-a-plane requests) and control (obtaining permission to fire) requirements. When the communication required to effect action was finally received, it was "history" as opposed to "news" (relevant information). Thus, fleeting targets were again lost before supporting arms could be brought to bear.

3. Natural:

After entering thick vegetation and losing contact with their supporting unit, many patrols prematurely aborted their mission and returned to base as per SOP. It was later discovered however, that little or no consideration was given to the limitations placed upon communications

equipment by the operating environment. Had communications personnel been more experienced and knowledgeable of the basic fact that dense foliage absorbs radio waves thereby seriously impairing the normal operating ranges (of FM radios operating in the VHF band), many patrols could have continued their mission by moving a short distance from the dead space they were currently in and reestablishing communications.

4. First Aide:

Probably the most recognized and costly (as measured in terms of nonessential casualties) incidences of communication failures occurred at the small unit level when engaged in the attack. Despite repeated commands from individual leaders, Marines repeatedly ignored them to rush to the aide of an injured Marine. Besides disregarding the immediate orders of a superior, Marines were also violating lessons learned (dispersion, laying base of fire) during basic training. This proclivity to aide injured Marines instead of following orders contributed to a significant number of nonessential casualties as:

a. it reduced their outgoing rate of fire (thereby encouraging the enemy to increase theirs) resulting in a loss of momentum paricularly during the attack phase.

b. undispersed Marines afforded a larger and more lucrative target to the enemy. The costs associated with these actions were seriously aggravated by the enemy's employment of area explosives (grenades, mortars...).

Thus,each incapacitated Marine contributed to a synergetic affect enjoyed by the enemy. (i.e. single casualty actually resulted in more than one weapon and one Marine becoming inoperational).

5. Fire Discipline:

Marines also exhibited a tendency to break fire discipline during intense operations despite repeated instructions to the contrary. Consequences of these actions resulted in many failed missions as positions were compromised, the element of surprise was lost and an inordinate amount of ammunitions was expended. These actions contradict those experienced by soldiers in WW II (as S.L.A. Marshall discovered that weapons were not fired despite orders to do so) and reflects that in the "heat of the moment", any attempts at communicating effectively may prove fruitless.

6. Overload:

One common burden shared by small unit leaders (platoon and company commanders) upon contact with the enemy was the lack of accurate, systematic and timely reporting of contact with the enemy to higher headquarters. Because of other on-site demands (i.e. orchestrating fire support coordination and manuever on the battlefield) placed upon the unit commander, the reporting of contacts was oftentimes delayed or ignored. These unintentional communications slip oftentimes served to aggravate an already serious situation such as either receiving late or not receiving at all resources requested from but controlled by higher headquarters (fire support, medevacs, logistics...).

7. Passing the Word:

Keeping oneself and everyone else around oneself informed was the most common communication dilemna encountered. Countless daily incidents occurred whereby "passing the word" was not accomplished. The consequences of these communication failures were innumerable preventable accidents (attributed to ignorance, inattention or carelessness), resulting in failed missions, serious injury and death. As mentioned earlier, the gravity of this

situation was recognized by Marshall who believed that one-third of the combat casualties could be attributed to carelessness.

The importance of keeping everyone informed was particularly important because once a single link was severed, "snowballing" occured as every uninformed member was now subject to becoming the innocent victim of his own, or his buddy's ignorance of the situation.

Representative examples of these types of communication failures included repeated incidences of shooting other patrol members while on missions in jungle terrain. For example, a patrol leader may have changed the patrol formation (from a double column to a "V") without all the members receiving word. When activity to the front and sides was later detected, forward patrol members were shot by uninformed members comprising the rear guard.

Other common occurrences of a similar nature involved sentries shooting patrol members returning to friendly lines through their area of observation (as they never received word of the time and place of the patrols return as per SOP, and therefore assumed the activity was enemy movement).

8. Inaccurate Reporting:

It was noted that there existed situations and/or tendencies whereby a subordinate deliberately tailored his responses to a senior. As an example, it was not uncommon for a subordinate to respond to a POSREP (position report) confirming that he was at a certain position (i.e. LZ, checkpoint, objective...) at a certain time, when in fact he was still short of his destination.

These actions at times served to jepoardize the success of a mission and safety of individuals (i.e calling fire support within danger close limits or on top of one's own position).

VI. ERROR ANALYSIS

The intent of this chapter is to;

1. isolate the common denominator(s) which explains (in terms of information and communication theory) the occurence of each event or situationally triggered communications error described above.

2. make practical recommendations as to how these types of errors can be avoided in future military operations.

3. construct a communications model (incorporating all of the common denominators) which serves to predict the type of communications errors to be expected or considered when communicating in a particular situation.

A. CATEGORY I

Communication errors associated with the presence of the first three events or situations (medevacs, fire support and natural environment) are uninteresting with regards to explaining their occurrence in terms of information or communication theory. Although the effects (number of casualties or failed missions) of these communication failures were not trivial, their causes were. The principle agents contributing to each communication failure can be explained in terms of:

1. lack of coordination during medevac operations

2. oversights with regards to communication requirements (shackle sheets)

3. redundancy and/or overcontrol inherent in fulfilling safety requirements (danger-close, save-a-plane request)

4. lack of knowledge and/or experience resulting in the communicators inability to correlate their radios operating characteristics (capabilities and limitations) with the operating environment.

In view of the aforementioned, and for the sake of future discussion related to DSS applications, the contributing agents to Category I communication errors will be considered as being partially "structured" in nature.

B. CATEGORY II

The remaining communication errors can all be explained in terms of the information and communication theory previously discussed. As all have subtleties associated with their occurrence (accounted for in terms of attitudinal, behavioral or cognitive phenomena), they will be considered as "unstructured" types of communication errors. The "justification" for the occurrence of each of these systematic errors is discussed below.

1. First Aide:

On the surface, this action appears as nothing more than a direct disobedience of an order (DDO). Its occurrence however is predicted by both Norman's work [Ref. 15] and Nan Lin's Conceptual Approach to communication theory. Together they state that deviations in behavior may be triggered when attitudinal conflicts develop in particular situations. They also assert, that given the proper situation (to generate such conflicts), the resultant deviations can be categorized into behavioral patterns as oppossed to isolated behavioral incidents. Nan Lin also insists that although an individual may participate in encounter and exchange, he may still not be influenced by it due to the situation. He further stipulates, that atypical behavior may result despite the presence of amplifying phenomena (i.e. rank structure, doctrine engrained in basic training, self-preservation) which usually serves to reinforce the communicated message.

Heider [Ref. 16] also supports these contentions through his Process Approach, by asserting that any attempts at communication will fail if unbalanced states exist within his framework (i.e. source and receiver do not share the same view about a particular issue).

The observed communication failures are considered as an intrapersonal event. The antecedent conditions causing them to surface result from an unconscious reordering of the many attitudes which transpires as a function of the situation. Therefore, for every event, each attitude is unconsciously "weighted" or reassessed with regards to other attitudes in the "attitudianal hierarchy". Thus, in some situations an individual may rank his attitudes higher toward a peer than toward a senior (under normal circumstances, the opposite would be expected). Additionally, as attitudes and behavior are normally directly correllated (i.e. common exception: racial prejudice where a person's behavior does not necessarily reflect his attitude), an individual's behavior will reflect his "deviant" attitude toward the situation (i.e. rescuing buddy versus obeying orders of superior). Once the situation passes (i.e. aide rendered), another reranking of attitudes may then occur resulting in more normal behavior.

The crux of the issue is that different situations activate a different set of rank-ordered attitudes, and if an undesireable reordering (known to commonly occur) is to be prevented in given situations (also known), the desired

attitude must be more deeply engrained in the individual before a potential attitudinal and behavioral altering situation occurs.

Research has shown that the most effective way to accomplish this is through training, whereby individuals are advised of the importance (and consequences) of maintaining (not maintaining) a given attitude in a given situation. Unless this indoctrination occurs, experience has shown that communication failures will continue to occur despite concerted efforts to prevent them.

The excessive costs (nonessential casualties) associated with the widespread occurrence of this phenomena in Vietnam were recognized. Efforts to alleviate the problem however, did not meet with much success. This fact leads one to speculate on the extra number of nonessential casualties that would be sustained should women ever be allowed into combat (given the protective nature of the male).

2. Fire Discipline:

The contributing agents to communication failures associated with this activity are much the same as discussed above. This fact illustrates that although repeated failures of unit leaders to maintain control was widely

noted under such circumstances, repeated efforts (training, briefings) to compensate for such communication failures were unsuccessful. These actions may illustrate the fact that their exists particular situations where emotions take over, and any attempts to influence individual behavior or action through communications may prove ineffective.

3. Overload:

Miller [Ref. 17] explained this issue by stating that there exists learned, natural (i.e. electrical/chemical processes limit a human to 2 active-cognitive decision/second) and absolute ("magical number 7") phenomena affecting the human's information processing abiltiy and capacity. If any of these limits are taxed (common in intense situations), communication errors result due to omitting, transposing or garbling essential pieces of information. This implies that there is a limit placed upon the amount and rate that information may be effectively processed by an individual. And as total capacity increases, accurracy decreases. The stipulations contained in paragraphs VI.B.1.7 & 8 also support this contention. Aggravating this phenomena, is the fact that maximum information processing effectiveness is achieved when

information is arranged in logical progression. In the combat arena however, information is usually communicated in chronological progression.

In summary, there exists an upper limit upon which the receiver can match responses to input stimuli. And if the amount and rate of information content and flow cannot be altered, then another receptor must be employed to relieve the information processing burden.

Research has proven [Ref. 18] that message processing is greatly influenced by battlefield events and individual activity. During critical portions of a mission (the attack), severe task overloading occurs which results in the deletion or deferral of many duties. Thus, when actively engaged, a commander may acknowledge receipt (encounter) of a message and then subconsciously place it in a "memory queue" to be extracted later when the situation allows. Upon retrieval, he may forget or alter its contents, or find it required immediate attention or action (at the time of reception) and is no longer relevant to the situation at hand.

Even though communications with higher headquarters normally requires the individual attention of the "actual"

(on-scene commander), III MAF recognized the burden placed upon the unit commanders and recommended that other individuals be trained and employed in communications to higher headquarters. This action was instituted to reduce communication errors with the peripheral benefit of allowing the individual unit leader to more appropriately focus his attention on the situation at hand.

III MAF's recommendation during the Vietnam War should be seriously considered with regards to any future Marine engagements. Given the projected nature of the operations and advances in weapons and communication systems technology, the communication demands placed upon the individual commander will continue to increase.

4. Passing the Word:

This inter-unit activity is best described by Campbell [Ref. 19] in his view of the human as a duplicatory-transmitter in a communication system.

With regards to information theory, both the quantity and quality of information suffer when the human is employed in this capacity. From a communications theory perspective however, the principle concern is the noise entering the medium with each exchange. Thus, faulty transmissions can be expected in similar activities due to:

1. fewer details included in each exchange.

2. details are changed (added, reweighted...).

3. inference being made by one link and subsequently decoded as facts by another link.

4. middle message loss in lengthy transmissions.

5. property of closure - tendency of individuals to fill gaps in messages based upon prior knowledge, experiences and prejudices.

6. STM (Short Term Memory) - on an average an individual heavily engaged in other activities (receiving constant and varying input) can accurately hold a message in memory for approximately 30 seconds. Furthermore, research has proven that in this span, an individual can retain no more than seven digits within his immediate memory (i.e. seven digit phone number takes this fact into account).

7. "Magic number 7" - depending upon the situation and irregardless of all other considerations, some messages may be just too complex for transmission if they contain too many (greater than seven) "pieces" of information. Research by Miller [Ref. 20] supports this contention as he discovered that an individual can expect to get (with any degree of accuracy) no more than 7 bits of output from 7

bits of input. This assertion coincides with previous findings reflecting that the human attention span is limited to 7 objects. Thus, if complex messages must be transmitted, and are to be accurately interpreted they must either:

a. stimulate more than the audio sense (i.e. visual; for example, the implementation of a DSS would fulfill this action).

b. include redundancy, as repeating something twice has been discovered to increase retention on an average of 15% (although this action is inefficient and impractical in a combat environment given the time, security and channel capacity restrictions inherent in combat operations).

8. current beliefs influencing what we hear. This factor reemphasizes the requirement to keep informed as any new information (either not familiar to, or shared by) will be resisted (property of inerita), rejected or twisted by the recipient.

9. closeness in proximity of each link to one another may actually prevent word from being passed on as the current recipient oftentimes perceives that the next

individual in the link has heard the message intended for himself (i.e. Inevitably, if "Pass it back" is given in a column formation, there are usually several members in the rear who never receive "the word").

10. the generally accepted limit (to ensure accurate transmission) in human exchanges is three. As such, transmitting a message through a squad (13) or a platoon (42) is inviting disaster.

Although all of these variables have a marked effect on efficient communications in these types of situations, the impact of the latter two may be the most pronounced, yet least recognized. Research has proven that these variables can be eliminated from communications if:

1. Chains of Command are utilized more often to pass the word (i.e. reduces total number of exchanges to inform the same number of people).

2. feedback is employed (i.e. communication should be a two way activity as opposed to a unidirectional channel) as it tells the source if and what information has been communicated to the receiver.

3. the transmitter (usually a senior) exercises a sense of empathy toward the recipient (subordinate). At this

point it should be noted that the Vietnam conflict was this nation's first teenage war (age of average soldier less than 20 years). This fact requires some attention, as a senior's ability to effectively communicate with subordinates at their level (in recognition of age, experience, background...) bears particular attention in view of the nonrepresentative sample of youths (larger percentage are teenagers, minorities, uneducated and poor than in the past) entering today's Armed Forces largely due to the AVF and state of the economy. These factors must be recognized as what we hear is largely a function of the frame of reference in which we are operating. And if they are not matched, any attempt at establishing effective communications in any situation will fail.

5. Inaccurate Reporting:

The occurrence of this practice is accounted for in research conducted by both Campbell [Ref. 21] and Manis [Ref. 22]. They discovered that in interpersonal communications where a senior- subordinate relationship exists, the transmitter may deliberately distort his communication to please the receiver. The degree of distortion is amplified even further in those situations

whereby the recipient exerts a great deal of influence (power, authority, charisma...) over the source.

Consistent with these findings, was the fact that such occurrences were noted only in situations where communications transpired between two different levels in the military hierarchy (Company/Battalion). This can be explained by the fact that communications with superiors are usually more deliberate than exchanges among subordinates (which are usually spontaneous). Its appearance in a military environment is therefore not surprising given the heavy emphasis placed upon rank structure.

Manis [Ref. 23] best summarized this phenomena by stating that "the innocent bearer of bad tidings may well be punished and may eventually learn that the safest course is to systematically bias messages (within limits) so that they are minimally offensive to listener(s)".

Campbell [Ref. 24] explains this behavior in terms of a motivational issue and appeasement mechanism. He asserts that a source may be so enamored with a recipient, that he will be motivated to "selectively shape" his output so as to make it congruent with the views of his sponsor.

It is generally believed that the best prevention against "half-truths" is to surround oneself with reliable people (who's word can be taken at face value). However, it should be recognized that virtually anyone is susceptible to such deviation, particularly in highly competitive or intense situations.

C. ERROR MODEL

I would like to extend Weissinger-Baylon's and Tonnison's communication error model which defines communications in terms of the elemental approach. Empirical research supporting its formulation is based primarily upon studies conducted in civilian occupations which depend heavily upon communication systems (i.e. ATC). As such, it addresses those situations or occupations characterized by interactions among single senders and single receivers of essentially the same status.

My extension proposes that a taxonomy of combat induced errors can be constructed as a function of the relative direction of communications flow in the military hierarchy. Specifically, the type, frequency, and causes of communication errors are largely determined by the relative position (senior, contemporary, subordinate) of the source

to the recipient. This approach also serves to recognize and/or reinforce the :

1. dimensional approach to the definition of communications.

2. organizational process view of decisionmaking (to be discussed latter).

3. heavy emphasis placed upon structure (i.e. rank, units) by the military.

In view of the aforementioned, the 8 systematic errors discovered can be categorized into 3 different hierarchical groupings as follows.

1. Communications to Subordinates
   a. First Aide
   b. Fire Discipline
2. Communications among Contemporaries
   a. Passing the Word
3. Communications to Seniors
   a. Marginal Reporting
   b. Overload
   c. Medevacs
   d. Fire Support
   e. Natural

The communication errors included in the first two categories (exchanges among subordinates and peers) can be explained in terms of information and/or communication theory. As discussed earlier, research findings in the cognitive, attitudinal or behavioral sciences support the occurrence of these types of errors in related situations. For example, communication errors associated with the first task (first aide) can be explained in terms of the conceptual definition of communication, as well as attitudinal and behavioral phenomena. All three errors are labelled under the more general heading of Category II errors.

Errors in communications directed at seniors however, were previously sorted as either Category I or Category II errors. The first two errors (marginal reporting and overloading) associated with communications to superiors can be classified as Category II errors as there exists attitudinal and behavioral phenomena explaining their occurrences.

The other errors however, could not be explained in terms of systematic errors or biases inherent in information and/or communication systems. As such, they are classified

as Category I errors as their occurrence can be attributed to "procedural shortcomings". Our concern is with the prevention of these latter types of errors through the use of DSSs.

VII. DECISION SUPPORT SYSTEMS

A. GENERAL

Historically, computers were used to increase the efficiency as opposed to the effectiveness of a function. Today's technology (hardware, software, interactive capability...) however, has advanced to the point where computers can now support individual operations (i.e. managerial activities) as opposed to functions (i.e. accounting). As such, Decision Support Systems represent the natural evolution of computer based technology to assist an individual in performing a particular task.

DSS's are based upon the premise that more effective decisions can be reached (and tasks executed) if those portions of the decision best accomplished by man (i.e. judgement, intuition) and machine (i.e. computation) are executed separately, and then integrated to arrive at a common decision. This approach focuses upon balancing human and computer resources by ensuring the computer enhances (as opposed to replaces) the human decisionmaking process.

B. SPECIFIC

According to Keen and Scott-Morton, "a DSS implies a conversational interactive computer system with some form of terminal for the analytical power, models and data bases held in the machine" [Ref. 25]. Furthermore, they assert that the following three activities are the principle purposes of Decision Support Systems.

1. Assist individuals in their decision process in semi-structured tasks.

2. Support managerial judgement.

3. Improve the effectiveness as opposed to the efficiency (implies a time and cost minimization) of the decisions.

In view of these assertions, Keen and Scott-Morton contend that a DSS may prove expedient in the following situations.

1. Manipulation is required of a data base too large for individual conceptualization.

2. Computation is required to arrive at a solution.

3. Time constraints exist to arrive at the final answer.

4. A judgement requirement exists to determine the problem, evaluate alternatives and choose a solution.

To recapitulate, they state that "a DSS provides a coherent strategy for going beyond the traditional use of computers in structured situations while avoiding ineffectual efforts to automate inherently unstructured ones". [Ref. 26].

Before proceeding to the military applications of Decision Support System's, the following peripheral issues relating to DSS's should be addressed.

1. DSS's focus upon semi-structured decisions or tasks. As a matter of perspective, structured decisions involve repetitive and routine determinations that can be resolved exclusively through the execution of an existing algorithm (i.e. EOQ). Unstructured decisions (associated with intuition, turbulent environments, judgement...) are either currently unprogrammed or incapable of being programmed, and therefore rely soley upon human cognition for solution.

Semi-structured decisions involve those decisions or tasks that can be neither completely automated, nor reached as a function of human cognition alone due to the scale/complexity of the problem. As such, varying degrees of subjective human assessments and objective computer determinations are involved depending upon the situation.

2. DSS components includes men, computers and information. It will therefore be only as strong as its weakest link, as the effectiveness of any decision depends upon the information system, human cognition and "insight" offered by the computer.

3. DS is concerned with constructing a system to support the key decisions or tasks associated with a specific type of operation. As such, supportable tasks (semi-structured) must first be identified to include partioning the decision process into structured (objectively oriented and computer implemented) and unstructured (subjectively oriented and human implemented) components. The DSS must then be designed commensurate with the appropriate decisionmaking school of thought (i.e.rational, satisficing, organizational, political, individual differences).

4. After determining the decisions, the information requirements (source, frequency, currency...) needed to support different types of decisions (strategic, operational, managerial) must be addressed. The crux of this isssue is that more reliable, accurate and timely information improves the quality of any decision. And as such, the DSS must ensure complete and current data bases are accessible.

C. MILITARY APPLICATIONS

To understand the potential applications of DSS in combat operations, it should be noted that in order to survive in a hostile environment, effective (vice efficient) decisions and actions need to be executed. This tenet implies that the implementation of a DSS in combat environments is particularly relevant, given that a DSS's expressed purpose is to improve the effectiveness of decisions for certain tasks.

Analogous to this issue is the fact that a hostile environment increases the demand for information, which in turn increases the demand on communication systems. This activity oftentimes serves to generate communication errors, many of which contribute to mission failures or disasters. In view of the characteristics of a DSS, it is also asserted that the implementation of the same will alleviate or eliminate many of these errors.

As the design of any DSS is primarily task dependent, an analysis of the tasks it may be required to perform is in order.

Marine Corps doctrine for conducting land warfare stresses:

1. manueverability

2. firepower, to include

   a. target acquisition

   b. massing of fires

3. communications

Additionally, the successful execution of any one of these activities is further complicated during coordinated air-ground missions peculiar to the USMC.

In view of the scope and diversity of these activities, it is imperative to establish and maintain reliable communications (so that information may be received and projected up and down channels) in order to make:

1. unique

2. repetitive, and

3. timely decisions.

Thus, the nature of the task and decisions to be performed during land engagements clearly illustrate the potential benefits to be gained by the implementation of a DSS in particular operations.

As their are differing points of view regarding the mechanices of decisionmaking (and therefore the criteria considered in designing a DSS), consideration must be given to peculiarities associated with the three principle components of a DSS employed in military environments.

First, information can be classified as tactical (i.e. fire support requests), non-tactical (i.e.logistic requests) or intelligence (i.e. enemy, environment). Each class is unique in that although all three may come from a single source (ground commander), they are rarely directed at a single recipient (channeled to respective staff or special staff Officers).

Additionally, they are updated continually (with information internal and external to the organization), and generally transmitted between units on different levels in the military hierarchy. Thus, a DSS implemented in related environments may be required to access several constantly changing data bases thereby increasing the degree of complexity of the system.

Secondly, the military structure, nature of operations and span of control dictates that many decisions will be executed at one level and implemented at another (by subordinate unit). This practice illustrates the extreme interdependency between communications and DSS's (given that each simultaneously supports, and is supported by the other system).

Thirdly, from a technological perspective, the technology now exists (software, hardware, size, weight...) so that a DSS can be employed in a combat environment.

In view of the aforementioned, I would submit that the design of DSS for implementation in related situations should focus upon the organizational process view regarding decisionmaking. Besides accounting for the above factors, Keen and Scott-Morton assert that effective decisions can be realized using this approach providing the following are understood.

1. the formal and informal structure of the organization.

2. Standard Operating Procedures (SOP) utilized by the organization.

3. Channels of Communications.

For example, they assert that support packages can be developed for the myriad SOP's in the military permitting problem solving procedures to be executed more efficiently and rapidly.

Additionally, since this approach focuses upon the relationships among organizational subunits, it also assists in integrating their activities.

For illustrative purposes, implementation of a DSS of related design could have reduced the frequency of occurence of Category I communication errors, and rendered effective decisions for the task at hand. As an example, the decision to send a reconaissance patrol on a mission without proper fire support (due to inablity to communicate) could have been prevented by ensuring the activities of the artillery and ground units were fully integrated through use of an "event triggering" DSS capability (i.e. exception type reporting). Communications Officers sharing the same DSS resources however, could have been alerted as to the discrepancy, and corrected it by informing the individual unit commanders at the pre-operational brief.

1. Disadvantages

1. Educational/Skill level - requires trained operators.

2. Vulnerability - elimination/incapacitation of a few "nodes" (skilled operators, pieces of equipment) jeopardizes operation of entire system.

3. Duplicity - requirement to maintain backup system creates financial, maintenance and logistic burden.

4. Redundancy - in systems as individuals must remain proficient in former method of operation in case the DSS is disabled.

5. Inertia - resistance to change (accept DSS) always a problem.

6. Organizational Impact - overdependence upon the system by the commander could result in the commander becoming more remote from his unit leaders and thereby risking being perceived as a manager as opposed to a leader (DSS is designed to support versus make decisions by providing accurate and relevant real time information).

7. Leadership Impact - potential exists for subordinates to perceive a shift in emphasis from a human oriented, to a hardware oriented (mission) style of leadership.

8. Human Factors considerations - must be completely recognized and accounted for to ensure optimal system design and implementation.

9 Centralization - that a few will control all (notion that having access to information constitutes a legitimate source of power).

2. Advantages

1. Time savings - unit commanders receive real-time information thereby improving the timeliness and quality of decisions.

2. Personnel savings - a few trained/skilled operators replace superfluous manual laborers.

3. Weight savings - bulky equipment replaced by "compact" equipment.

4. Space savings - same.

5. Standardization - continuity incorporated into DSS.

6. Event triggered reponse capability - allows for more fapid response and relievs staff and special staff officers of routine duties.

7. Integrates - information shared by subunits.

8. Control - facilitates control or unit resources.

9. Visual Display - reduces potential requirement for redundancy.

VIII. CONCLUSIONS

Error analysis revealed that a large number of nonessential battlefield casualties resulted during the execution of particular types of operations. Further analysis disclosed that a significant number of these casualties could be attributed solely to systematic communications failures associated with the particular task. The most important conclusions to be drawn from these findings are reflected below.

1. Systematic communication errors contributed to a significant number of nonessential casualties or failed missions during land combat operations conducted by the USMC in Vietnam.

2. The majority of errors were nonstructured in nature, and as such non-DSS supportable. Of these errors, many can be expected to occur in future engagements, as they were either attitudinally or behaviorally precipitated. The best countermeasures to reduce their impact, is the ability to recognize - and compensate for - those situations where they are likely to occur.

3. The remaining errors were considered semi-structured in nature and as such, are DSS supportable. Implementation of an effective DSS is however, contingent upon recognizing the unique tasks, structure, decision points, SOPs and channels of communication in a military environment. Given the critical real time constraints associated with military operations, DSS's would prove themselves especially valuable if they possessed an "event triggered" capability. Used in this capacity, they would prove especially useful to Staff (S-1, S-2, S-3, S-4) and Special Staff (i.e. MMO, CommO) Officers given the tremendous amount of information they are required to maintain and process repeatedly. Their use by individual commanders however is considered neither practical nor feasible due to:

a. the nature of combat operations

b. image (leader vs. manager) required to be projected to subordinates on the battlefield.

It should be recognized that DSS's do not constitute a panacea with regards to reducing systematic communication errors inherent in combat operations. What they do represent however, is a natural and technological progression in the "tools" (i.e. teletype, radio...)

designed to assist the commander on the modern battlefield. As such, the tasks, situations and environment in which they can be effectively operated must be recognized.

This study identified those tasks and situations (where an inordinate number of nonessential casualties) in which the implementation of a DSS could reduce the associated systematic communication errors (contributing to the casualties). It also identified those situations in which the use of a DSS would have no effect, and as such, the commander must concentrate his energies on other approaches (i.e. indoctrination, training...) designed at solving the problem.

Although this study was limited in its approach, it has become evident that further analytical work needs to be accomplished concerning the study of unstructured systematic communication errors occurring in combat. Even if their occurrences cannot be prevented, merely identifying those situations or tasks in which they are likely to occur will yield tremendous benefits in predicting the consequences and costs of future operations.

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